

Claims

[c1] What is claimed is:

1. A fluid–dynamic–pressure bearing comprising:
 - a shaft;
 - a top plate fixed to an upper portion of the shaft;
 - a thrust plate fixed to a bottom portion of the shaft;
 - a circular cylindrical sleeve, either said sleeve or said shaft being rotatable relative to the other, said sleeve with respect to said shaft and with respect to said top plate defining a continuous micro–gap;
 - a roughly cuplike bearing housing inner–circumferentially retaining the sleeve and whose lower end is closed;
 - lubricating fluid filling the micro–gap;
 - a radial bearing component formed in between respective surfaces of said shaft outer–circumferentially and said sleeve inner–circumferentially, said radial bearing component being provided with radial dynamic–pressure–generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins;
 - an upper thrust bearing section formed in between respective surfaces of said top plate bottom–wise and said

bearing housing rim-wise, said upper thrust bearing section being provided with upper thrust dynamic-pressure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins; and
a lower thrust bearing section formed in between respective surfaces of said sleeve bottom-marginally and said thrust plate top-marginally, said lower thrust bearing section being provided with lower thrust dynamic-pressure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins.

[c2] 2. A fluid-dynamic-pressure bearing as set forth in claim 1, wherein in between respective surfaces of said sleeve outer-circumferentially and said bearing housing inner-circumferentially, a communicating pathway is formed so that where one end of said pathway opens is radially inward from the upper thrust bearing section, and so as to communicate with the lower thrust bearing section nearby its outer periphery.

[c3] 3. A fluid-dynamic-pressure bearing as set forth in claim 2, wherein said communicating pathway is constituted by an axial groove formed in the outer circumferential surface of said sleeve, and by the inner circumferential surface of said bearing housing.

[c4] 4. A fluid-dynamic-pressure bearing as set forth in claim 2, wherein:

said radial bearing component is configured by an axially separated pair of radial bearing sections formed in between the outer circumferential surface of said shaft and the inner circumferential surface of said sleeve, and in at least one of said pair of radial bearing sections axially imbalanced herringbone striations for inducing axially upward-to-downward-acting dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins are provided as said dynamic-pressure-generating grooves; and

in said upper thrust bearing section and in said lower thrust bearing section spiral striations for inducing radially inward-heading dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins are respectively provided as said upper thrust and said lower thrust dynamic-pressure-generating grooves.

[c5] 5. A fluid-dynamic-pressure bearing as set forth in claim 4, wherein:

a circumventive projection is formed on said top plate, said circumventive projection extending axially downward from said top plate and radially opposing via a clearance said bearing housing along its outer circumferential surface;

heading axially downward, from said top plate, along the clearance the radial dimension of the clearance widens; and
oil as said lubricating fluid is retained in the clearance, the oil forming an air-liquid interface within the clearance.

[c6] 6. A fluid-dynamic-pressure bearing as set forth in claim 5, wherein said sleeve is formed from a porous, oil-impregnated sintered metal.

[c7] 7. A fluid-dynamic-pressure bearing as set forth in claim 6, wherein the roughness of the outer circumferential surface of said shaft is $0.1\ \mu\text{m}$ or more but $1.6\ \mu\text{m}$ or less Ra .

[c8] 8. A fluid-dynamic-pressure bearing as set forth in claim 6, wherein the roughness of the outer circumferential surface of said shaft is from $0.3\ \mu\text{m}$ to $0.8\ \mu\text{m}Ra$.

[c9] 9. A fluid-dynamic-pressure bearing as set forth in claim 6, wherein:
said sleeve is fixed by means of an adhesive to the inner circumferential surface of said bearing housing;
an adhesive groove indented radially into either the outer circumferential surface of the sleeve or the inner circumferential surface of the bearing housing, or into

both, is formed where said sleeve and said bearing housing abut on each other;
said adhesive is retained in said adhesive groove.

[c10] 10. A fluid-dynamic-pressure bearing as set forth in claim 6, wherein:

said bearing housing comprises a circular cylindrical member having an inner circumferential portion for retaining said sleeve, and a counterplate closing over the lower end of said cylindrical member; and
said counterplate and said cylindrical member are fixed to each other by welding.

[c11] 11. A fluid-dynamic-pressure bearing as set forth in claim 6, wherein said shaft and said top plate are formed integrally.

[c12] 12. A fluid-dynamic-pressure bearing as set forth in claim 10, wherein:

the locus in which said counterplate and said cylindrical member are welded together is situated radially outward from the inner circumferential portion of said cylindrical member; and

along the inner circumferential portion of said cylindrical member, a recess is formed radially opposing said thrust plate along its outer periphery, for absorbing deformation of said cylindrical member due to the welding.

[c13] 13. A spindle motor comprising:

- a shaft;
- a top plate fixed to an upper portion of the shaft;
- a thrust plate fixed to a bottom portion of the shaft;
- a circular cylindrical sleeve, either said sleeve or said shaft being rotatable relative to the other, said sleeve with respect to said shaft and with respect to said top plate defining continuous micro-gap;
- a roughly cuplike bearing housing inner-circumferentially retaining the sleeve and whose lower end is closed;
- a bracket having a portion whose inner periphery is for supporting said bearing housing;
- a stator anchored to said bracket;
- a magnet retained by said top plate, for generating a rotating magnetic field by interacting with said stator
- a dynamic-pressure bearing configured along said micro-gap, for supporting either said sleeve or said shaft rotatably relative to the other;
- said dynamic-pressure bearing including lubricating fluid filling the micro-gap;
- a radial bearing component formed in between respective surfaces of said shaft outer-circumferentially and said sleeve inner-circumferentially, said radial bearing component being provided with radial dynamic-pres-

sure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins;

an upper thrust bearing section formed in between respective surfaces of said top plate bottom-wise and said bearing housing rim-wise, said upper thrust bearing section being provided with upper thrust dynamic-pressure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins; and

a lower thrust bearing section formed in between respective surfaces of said sleeve bottom-marginally and said thrust plate top-marginally, said lower thrust bearing section being provided with lower thrust dynamic-pressure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins.

- [c14] 14. A spindle motor as set forth in claim 13, wherein in between respective surfaces of said sleeve outer-circumferentially and said bearing housing inner-circumferentially, a communicating pathway is formed so that where one end of said pathway opens is radially inward from the upper thrust bearing section, and so as to communicate with the lower thrust bearing section nearby its outer periphery.

- [c15] 15. A spindle motor as set forth in claim 14, wherein said communicating pathway is constituted by an axial groove formed in the outer circumferential surface of said sleeve, and by the inner circumferential surface of said bearing housing.
- [c16] 16. A spindle motor as set forth in claim 14, wherein: said radial bearing component is configured by an axially separated pair of radial bearing sections formed in between the outer circumferential surface of said shaft and the inner circumferential surface of said sleeve, and in at least one of said pair of radial bearing sections axially imbalanced herringbone striations for inducing axially upward-to-downward-acting dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins are provided as said dynamic-pressure-generating grooves; and in said upper thrust bearing section and in said lower thrust bearing section spiral striations for inducing radially inward-heading dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins are respectively provided as said upper thrust and said lower thrust dynamic-pressure-generating grooves.
- [c17] 17. A spindle motor as set forth in claim 16, wherein: a circumventive projection is formed on said top plate,

said circumventive projection extending axially downward from said top plate and radially opposing via a clearance said bearing housing along its outer circumferential surface;

heading axially downward, from said top plate, along the clearance the radial dimension of the clearance widens; and

oil as said lubricating fluid is retained in the clearance, the oil forming an air-liquid interface within the clearance.

- [c18] 18. A spindle motor as set forth in claim 17, wherein said sleeve is formed from a porous, oil-impregnated sintered metal.
- [c19] 19. A spindle motor as set forth in claim 18, wherein the roughness of the outer circumferential surface of said shaft is 0.1 μm or more but 1.6 μm or less *Ra*.
- [c20] 20. A spindle motor as set forth in claim 18, wherein the roughness of the outer circumferential surface of said shaft is from 0.3 μm to 0.8 μm *Ra*.
- [c21] 21. A spindle motor as set forth in claim 18, wherein: said sleeve is fixed by means of an adhesive to the inner circumferential surface of said bearing housing; an adhesive groove indented radially into either the

outer circumferential surface of the sleeve or the inner circumferential surface of the bearing housing, or into both, is formed where said sleeve and said bearing housing abut on each other;
said adhesive is retained in said adhesive groove.

[c22] 22. A spindle motor as set forth in claim 18, wherein:
said bearing housing comprises a circular cylindrical member having an inner circumferential portion for retaining said sleeve, and a counterplate closing over the lower end of said cylindrical member; and
said counterplate and said cylindrical member are fixed to each other by welding.

[c23] 23. A spindle motor as set forth in claim 18, wherein
said shaft and said top plate are formed integrally.

[c24] 24. A spindle motor as set forth in claim 22, wherein:
the locus in which said counterplate and said cylindrical member are welded together is situated radially outward from the inner circumferential portion of said cylindrical member; and
along the inner circumferential portion of said cylindrical member, a recess is formed radially opposing said thrust plate along its outer periphery, for absorbing deformation of said cylindrical member due to the welding.

[c25] 25. A method of manufacturing a rotor assembly for a spindle motor outer peripherally on which at least one recording disk is retained, the rotor assembly including a shaft defining a cylindrical outer surface, a top plate having a circular platelike top-wall portion defining an undersurface and formed unitarily with an upper portion of said shaft, a cylindrical wall portion defining cylindrical inner and outer surfaces and depending from said top-wall portion outer-perimetrically, and a flange portion extending radially outward from said cylindrical wall portion, for carrying at least one hard disk, a yoke made of a ferromagnetic material, the yoke fastened to either of respective inner and outer circumferential surfaces of the cylindrical wall portion, with a magnet fixed correspondingly to either of respective inner and outer circumferential surfaces of the yoke, wherein the manufacturing method comprises: a step of casting said top plate by a plastic formation process; a step of fixing the magnet by means of an adhesive to one of either the inner or outer circumferential surfaces of the yoke; and a step of carrying out a milling operation on the cylindrical outer surface of the shaft, on the undersurface of the

top-wall portion of the top plate, on either the cylindrical inner or outer surface of the cylindrical wall portion, and on the recording-disk-carrying surface of the flange portion.

[c26] 26. A rotor assembly manufacturing method as set forth in claim 25, wherein the top plate is cast by a forging operation.

[c27] 27. A rotor assembly manufacturing method as set forth in claim 25, wherein the top plate is cast from aluminum or an aluminum alloy.

[c28] 28. A recording-disk drive, on which at least one circular platelike recording medium on which information is recordable is mounted, and including a housing, a spindle motor anchored inside the housing for rotating the recording medium, and means for in requisite positions writing information onto and reading information from said recording medium, wherein the spindle motor comprises:

a shaft;

a top plate fixed to an upper portion of the shaft;

a thrust plate fixed to a bottom portion of the shaft;

a circular cylindrical sleeve, either said sleeve or said shaft being rotatable relative to the other, said sleeve with respect to said shaft and with respect to said top

plate defining continuous micro-gap;
a roughly cuplike bearing housing inner-circumferentially retaining the sleeve and whose lower end is closed;
a bracket having a portion whose inner periphery is for supporting said bearing housing;
a stator anchored to said bracket;
a magnet retained by said top plate, for generating a rotating magnetic field by interacting with said stator
a dynamic-pressure bearing configured along said micro-gap, for supporting either said sleeve or said shaft rotatably relative to the other;
said dynamic-pressure bearing including
lubricating fluid filling the micro-gap;
a radial bearing component formed in between respective surfaces of said shaft outer-circumferentially and said sleeve inner-circumferentially, said radial bearing component being provided with radial dynamic-pressure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins;
an upper thrust bearing section formed in between respective surfaces of said top plate bottom-wise and said bearing housing rim-wise, said upper thrust bearing section being provided with upper thrust dynamic-pressure-generating grooves for inducing dynamic pressure

in said lubricating fluid when either said shaft or said sleeve spins; and
a lower thrust bearing section formed in between respective surfaces of said sleeve bottom-marginally and said thrust plate top-marginally, said lower thrust bearing section being provided with lower thrust dynamic-pressure-generating grooves for inducing dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins.

[c29] 29. A recording-disk drive as set forth in claim 28, wherein in between respective surfaces of said sleeve outer-circumferentially and said bearing housing inner-circumferentially, a communicating pathway is formed so that where one end of said pathway opens is radially inward from the upper thrust bearing section, and so as to communicate with the lower thrust bearing section nearby its outer periphery.

[c30] 30. A recording-disk drive as set forth in claim 29, wherein said communicating pathway is constituted by an axial groove formed in the outer circumferential surface of said sleeve, and by the inner circumferential surface of said bearing housing.

[c31] 31. A recording-disk drive as set forth in claim 29, wherein:

said radial bearing component is configured by an axially separated pair of radial bearing sections formed in between the outer circumferential surface of said shaft and the inner circumferential surface of said sleeve, and in at least one of said pair of radial bearing sections axially imbalanced herringbone striations for inducing axially upward-to-downward-acting dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins are provided as said dynamic-pressure-generating grooves; and

in said upper thrust bearing section and in said lower thrust bearing section spiral striations for inducing radially inward-heading dynamic pressure in said lubricating fluid when either said shaft or said sleeve spins are respectively provided as said upper thrust and said lower thrust dynamic-pressure-generating grooves.

[c32] 32. A recording-disk drive as set forth in claim 31, wherein:

a circumventive projection is formed on said top plate, said circumventive projection extending axially downward from said top plate and radially opposing via a clearance said bearing housing along its outer circumferential surface;

heading axially downward, from said top plate, along the clearance the radial dimension of the clearance widens;

and

oil as said lubricating fluid is retained in the clearance, the oil forming an air-liquid interface within the clearance.

[c33] 33. A recording-disk drive as set forth in claim 32, wherein said sleeve is formed from a porous, oil-impregnated sintered metal.